

ENTOZOA FROM THE AUSTRALIAN HAIR SEAL.

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(Twelve Text-figures.)

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In January, 1923, Professor F. Wood Jones, F.R.S., led a small biological party which visited Pearson Island, lying about twenty-five miles off the west coast of Eyre's Peninsula, South Australia. Amongst the material obtained were some entozoa collected by Professor J. B. Cleland from the Australian hair seal, *Arctocephalus forsteri* (Lesson). No species of parasite has, as yet, been recorded from our pinnipeds. Amongst the ectozoa known to occur on the hair seal may be mentioned a Pediculid, probably an undescribed species of *Antarctophthirius* or *Echinophthirius*. The entozoa referred to in this paper belong to three species, namely, a cestode, *Diphyllbothrium arctocephalinum*, n. sp.; a nematode, *Contra-caecum osculatum* (Rud.); and an echinorhynch, *Corynosoma australe*, n. sp. The types of the new species have been deposited in the South Australian Museum, Adelaide.

DIPHYLLOBOTHRUM ARCTOCEPHALINUM, n. sp. Figs. 1-7.

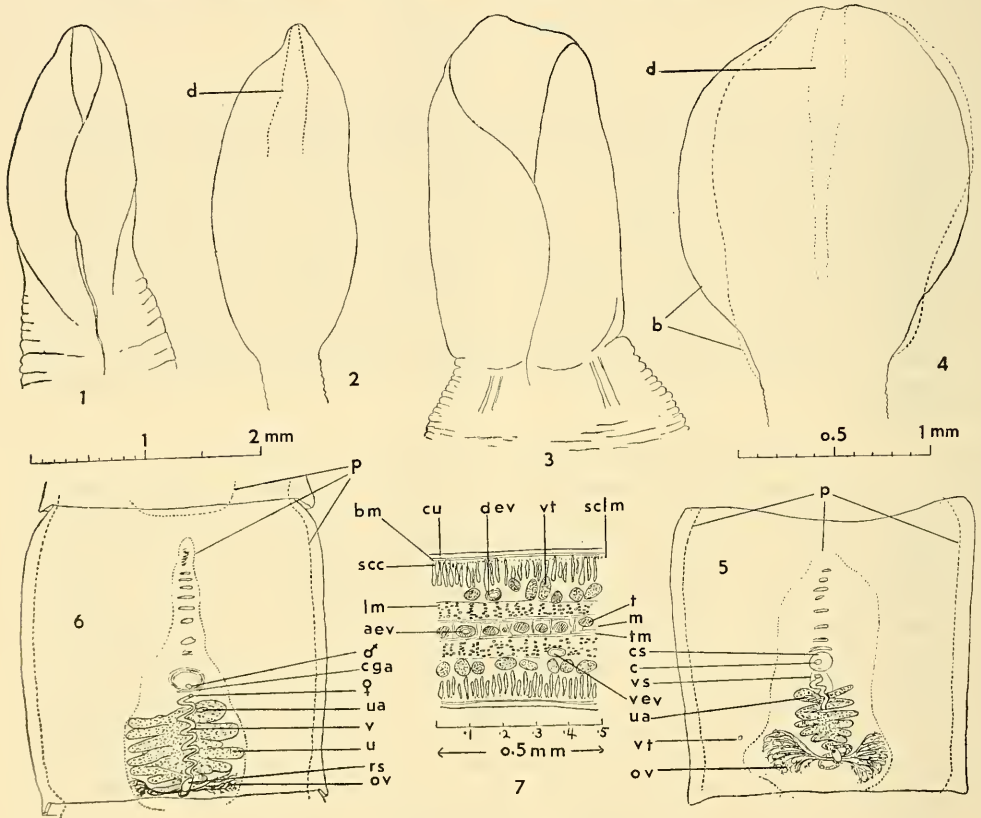
In the intestine of *Arctocephalus forsteri* there was found a tangled mass of cestodes whose separation resulted in some fragmentation. A specimen bearing a scolex was 17 cm. long, the terminal 5 centimetres bearing eggs. A fragment of another strobila was about 44 cm. in length, approximately 40 cm. of it being ovigerous. If one matched these two fragments according to the sizes of their segments and their reproductive condition, the total length of an unbroken strobila would be not less than 54 cm., of which more than 40 cm. would probably be egg-bearing. Segments which had just become ovigerous were nearly one millimetre long and 5 mm. broad, and sufficiently overlapping the succeeding proglottis to give a slightly serrate margin to the strobila. In strongly contracted strobilae the serrations were much more pronounced. Segments in the mid-region of the scolex-less strobila, mentioned above, were about 5 mm. wide and 2.5 to 3.1 mm. long, whilst those near the posterior end measured 6 mm. in width by 3.7 mm. in length.

Another fragment, 36 mm. long, possessed a markedly crinkled margin and all its segments were egg-bearing, but they were considerably wider and shorter anteriorly, 6 mm. and 1.5 mm. respectively, than in the corresponding portion of the other strobila. The length gradually increased to 3 mm. in segments at the end of specimen, the breadth becoming 8 mm. Hence, at first sight, there appeared to be two species represented in the material, but the anatomy was similar and the differences in dimensions were due no doubt to the state of muscular contraction.

The scolex was narrower than the succeeding segments, but, when viewed laterally, was seen to be at least twice as thick as the neck region. The dimensions varied according to the state of contraction. When relaxed the breadth was

0.65 mm. and the length from the tip to the posterior end of the bothrial groove was 1.5 to 2 mm., the very thin edge of one bothrium slightly overlapping the other (figs. 1, 2). The maximum dorsoventral thickness was 0.75 cm. The groove in some specimens extended back above the earliest segments. In one scolex the bothria were rather wider and the groove shorter, the organ being 0.95 mm. in breadth, 2.0 mm. in length, with a thickness of 1.5 mm. (fig. 3), the anterior extremity thus being almost round when viewed laterally (fig. 4).

There is a very short unsegmented neck, but since the bothrial grooves enter it, this region should perhaps be regarded more correctly as merely the narrowed



Figs. 1-7.—*Diphyllobothrium arctocephalinum*.

1, 2, Scolex, face and lateral views; 3, 4, a larger scolex, face and lateral views; 5, segment in which the uterus has just become egg-bearing, ventral (scale above); 6, mature segment, ventral (scale above); 7, portion of transverse section of mature segment to show relation of various glands and ducts.

(Figs. 1-5 drawn to scale indicated below Fig. 4.)

References to lettering.—aev, ? accessory excretory vessel; b, bothrium; bm, base-membrane; c, cirrus; cga, common genital aperture; cs, cirrus sac; cu, cuticle; d, tissue at side of scolex, between bothria; dev, dorsal excretory vessel; lm, longitudinal musculature; m, medulla; ov, ovary; p, boundary (dotted) of vitelline zone; rs, receptaculum seminis; scc, subcuticular cells; sclm, subcuticular longitudinal muscle fibres; t, testis; tm, transverse muscles; u, uterus; ua, uterine aperture; v, vagina; va, vaginal aperture; vev, ventral excretory vessel; vs, vesicula seminalis; vt, vitelline glands.

portion of the scolex. The breadth of this part is from 0.7 to 1.9 mm., with a thickness of 0.3 to 0.6 mm.

The common genital opening lies in the midline ventrally at, or just behind, the mid-length of the segment. The opening is a transverse or rounded slit, according to the degree of retraction or protrusion of the cirrus. Into the posterior wall of the genital atrium there opens the much smaller slit-like vaginal aperture, whose walls are well chitinated. Behind these openings is the tocostome or uterine aperture situated a little to one or other side of the median line (or sometimes in the mid-line) as a transverse slit at whose narrow base the metraterm terminates. In whole mounts the mid-region of each ripe or maturing segment shows the presence of differentiated tissue, apparently medulla, in front of the cirrus sac and extending almost to the anterior end of the proglottis. A series of short transverse grooves or folds are commonly associated with this region, but no differentiated organs were noticed there.

Transverse sections reveal the presence of a thick cuticle below which is a narrow, well-defined, less deeply staining, basement membrane, succeeded by sub-cuticular structures, the very large elongate fusiform cells being a marked feature. The sub-cuticular longitudinal muscle fibres are fairly well marked, but the transverse fibres are very minute. The cortex is occupied largely by the abundant vitellaria arranged in a single row dorsally and ventrally. The main longitudinal musculature forms a wide zone, the individual fibres being powerful and arranged more or less in small groups not completely separated to form distinct bundles. The transverse muscles are much less deeply staining. Dorso-ventral fibres are weakly developed. The medulla is relatively very narrow and contains many calcareous corpuscles. It is occupied largely by the testes, ovary and uterus.

The main excretory canals are remote from the margins of the strobila, both have a wavy course, and the narrower dorsal vessel lies nearer to the median line of the segment. Both sets of canals have muscle fibres in their walls. Transverse canals are absent, but small sinuous branching canals pass from the main channels into the tissues. Sometimes these branches are large and, when seen in transverse section, resemble the main canals in size. In addition to the canals just referred to, there is, on either side, lying in the middle of the medulla just inwardly from the level of the dorsal excretory canal, a very definite canal with cuticular walls and abundant fine longitudinal fibres (apparently muscular). It has a sinuous course like the other vessels and appears to be a supplementary excretory canal, since communication with other systems has not been traced. The ovarian lobes may extend laterally to the vicinity of these canals and actually overlie them dorsally. The tissue surrounding them is more differentiated than that around the ordinary excretory ducts. Their position suggested that they might be the two vasa deferentia, but the failure to trace any connection with the vesicula seminalis seems to negative the suggestion.

The testes did not stain in whole mounts, but were obvious in sections, though the state of fixation of the material was not sufficiently good to allow one to study these organs satisfactorily. They are very numerous and occupy most of the medulla in the region where they occur, and they tend to approach its upper border. Their boundary is much less sharply defined than that of the vitellaria. They measure 0.03-0.046 mm. in diameter, these dimensions being based on their appearance in transverse and horizontal sections. They are restricted to two definite testicular fields which are widely separated in the mid-region of the segment, but which join to form a very narrow band near the anterior margin. The testicular and vitelline zones seem to coincide, except laterally, where the

medulla is absent. The yolk glands lie above and below the testes and occur almost to the lateral margin of the segment. A considerable pyriform area with its base in the posterior part of the proglottis is devoid of both these glands, but is occupied in its hinder half largely by the mature uterus.

Above the anterior portion of the uterus, as well as in front of that organ, is the large, elliptical, rather thick-walled, vesicula seminalis, about 0.23 mm. long and 0.015 mm. wide, lying somewhat obliquely. From it there issues a short narrow ejaculatory duct surrounded by the large muscular, circular, or rather spherical, cirrus sac whose outer boundary is ill-defined. This sac is ventral from the vesicula. The everted cirrus is about 0.1 mm. long and 0.05 mm. in diameter, narrowing towards its free end. There is a definite atrium when the organ is fully retracted, the male pore lying in front of the vaginal aperture which is located on its posterior wall.

The vagina is well chitinized in the vicinity of the genital pore and passes backwards a very short distance and then upwards below the cirrus sac, becoming suddenly widened and thrown into a number of very thin-walled convolutions in a horizontal plane, but these coils do not extend very far on either side of the midline as the organ makes its way posteriorly immediately below the uterus, close to whose ventral wall it lies pressed. Just in front of the ovary, the vagina forms a rather large receptaculum which is twisted or curved and extends below and just behind the ovarian bridge to become connected with the fertilizing duct by a very narrow short canal.

The ovary does not stain readily in whole mounts, and is best studied in sections. It lies in the posterior portion of the segment, closely behind the uterus. The main mass on either side is of a delicate branching structure whose branches may unite to form a reticulum as they radiate outwardly and forwards. The lobes extend practically to the testiculo-vitelline region and tend to occupy the upper portion of the medulla, whereas those parts nearer the midline lie ventrally in the medulla, the narrow ovarian bridge lying ventrally from the hind portion of the uterus. An oocapt appears to be present. The short oviduct is soon joined by the receptaculum and the fertilizing duct now formed is joined by the rather wide yolk duct and then surrounded by the mass of shell glands. The canal now becomes curved and bent on itself, and then suddenly widening into the uterus which passes forwards and is thrown into a series of about eight to ten transversely-lying coils or loops. As the organ becomes more densely packed with eggs it becomes more rosette-like and swollen and the individual loops less distinct. The terminal loop is surrounded by thickened walls as it passes directly ventrally, the metraterm ending at the uterine pore some distance behind the common genital opening, and frequently a little to one or other side of the midline. Eggs are elliptical, measuring 0.052 to 0.057 mm. long by 0.035 to 0.038 mm. wide.

Yolk glands are extremely numerous and very small when seen in surface view, where they are commonly elongate in the direction transversely to the longitudinal axis of the segment. The vesicles are restricted to form two wide lateral zones which approach in the anterior half of the segment and eventually join to form a narrow band. They occupy a large part of the cortex ventrally and dorsally between the inner ends of the subcuticular cells and the main longitudinal musculature. They measure 0.030 to 0.057 mm. in maximum length by 0.01 to 0.013 mm. in width, and 0.030 to 0.040 mm. in dorsoventral diameter. The two main vitelline ducts pass inwards just behind, or just below, the ovarian bridge and unite to form a short common duct which enters the fertilizing duct.

The present species can be separated readily from *D. latum*, *D. cordatum*, *D. fuscum*, and *D. ranarum*, by the fact that in these species the uterine loops extend forwards to the sides of the genital pore. Though our species resembles *D. mansoni* and *D. houghtoni* in this feature, it differs from them in the arrangement of the loops. From *D. houghtoni* it differs also in the distribution of the testicular and vitelline fields, but it resembles *D. mansoni* in these respects. Baylis (1929) stated that in *D. mansoni* the very numerous testes were not arranged in distinct lateral fields, but Faust's figure (1930) indicates that they are. The form of the scolex and uterus, as well as the position of the genital pore, differentiate *D. arctocephalinum* from *D. reptans* and *D. ranarum* as described by Meggitt (1924; 1925). The shape of the scolex and of the neck region distinguishes our species from *D. cordatum*, *D. mansoni*, and many others. In *D. decipiens* the uterine loops are few and do not form a rosette. The dimensions of the strobila distinguish the Australian species from the small species described from southern seals.

The position of the common genital pore in relation to the length of the segment differentiates the species from nearly all others, since in *D. arctocephalinum* it lies either at, or behind, the midlength, whereas in others it is situated in front. The presence of the modified tissue extending forwards along the midline from the genital pore is a conspicuous feature in cleared, stained or unstained preparations. The dimensions of the eggs are different from those of all other species whose descriptions are available. The species which seems most nearly related anatomically is *D. mansoni*, but the main points of difference have been mentioned above. No cestode has been identified previously from Australian pinnipeds, though many are known from antarctic and subantarctic species.

The keys to species given by Meggitt (1924), Baylis (1929) and Sprehn (1932) have been consulted.

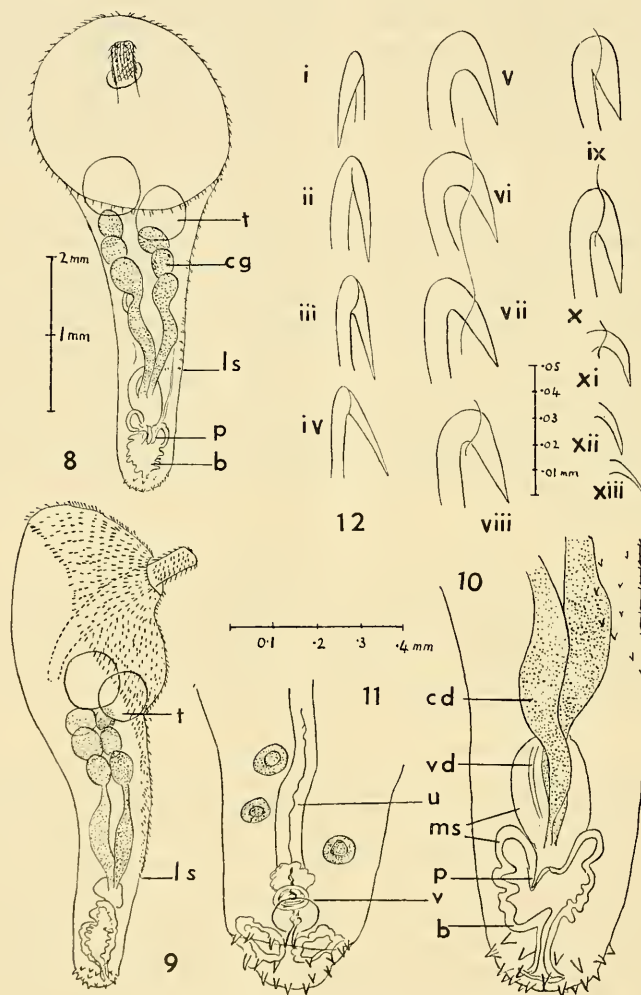
CONTRACAEUM OSCULATUM (Rud.).

This widely distributed nematode was represented by a young female specimen which exhibited the characteristic structure of the lips and the abundant fine striations at the anterior end. The species is known from northern seals as well as from several species which occur in the Subantarctic and Antarctic. It had not previously been recorded from Australian seals.

CORYNOSOMA AUSTRALE, n. sp. Figs. 8-12.

This minute parasite of *Arctocephalus forsteri* measures about 3.5 mm. in length, though specimens were examined ranging from 3 to 4 mm. Both sexes are similar in size and general form. The anterior body forms a rounded disc-like structure about 1.3 mm. in diameter, more or less flattened ventrally but arched dorsally, this region bearing very numerous, small, regularly arranged, spines. The rest of the body narrows rapidly and then becomes cylindrical for the last third of the total body-length where the diameter is 0.35-0.4 mm. The posterior end is rounded and is provided in both sexes with two circlets of spines (total 28-30) which are much larger than those on the rest of the body, and, as in other species of the genus, they give rise to triangular projections of the cuticle. Small spines similar to those on the dorsal and ventral surfaces of the disc are present on the ventral surface of the anterior part of the posterior body, the terminal quarter or fifth of the body-length being devoid of them except for the terminal group. The two best-known species, both occurring in eared seals (amongst other hosts) in the northern hemisphere, are *C. semerme* (Forsk.) and

C. strumosum (Rud.). The Australian parasite resembles the former in general form and size, but the distribution of the small spines is more like that in *C. strumosum* where, however, from more than a half (Meyer's figure, 1932) to two-fifths (Lühe's figure, 1911) of the body-length ventrally is devoid of them. The ratio of the diameter of the disc to that of the cylindrical posterior body (based on figures published by Lühe and by Meyer) is about 2.4:1 in the case of *C. strumosum*; about 2:1 in *C. semerme*; and 3:1 in *C. australe*. The ratio



Figs. 8-12.—*Corynosoma australe*.

8, ventral view of male; 9, lateral view of male; 10, posterior end of male; 11, posterior end of female (dorsal view); 12, rostellar hooks belonging to one longitudinal row and marked i-xiii according to their position from the free end of the proboscis.

(Figs. 8 and 9 are drawn to the scale indicated beside 8; 10 and 11 to scale above 11.)
References to lettering.—b, bursa; cd, cement duct; cg, cement glands; ls, most posterior spine on ventral surface; ms, muscular sac ("markbeutel"); p, penis; u, uterus; v, vagina; vd, vas deferens.

of the length of the disc to the total body-length is about 1:2.3-2.6 in *C. strumosum*; 1:1.3-1.6 in *C. semerme*; and 1:1.4 in *C. australe*. *C. strumosum* measures about 5 to 6 mm., but sometimes reaching 9 mm. in length; while *C. semerme* is only about 3 mm. (3-5 mm.).

The arrangement of the caudal spines in *C. australe* resembles that in *C. constrictum* as figured by Van Cleave (1918) and quite unlike that in *C. semerme*, where they are very abundant and the series joins up with the ventral body spines.

The proboscis in *C. australe* is about 0.7 mm. long, narrowed in its anterior third, but widening to 0.2 mm. behind its mid-length and then narrowing only slightly towards its base. The proboscis length is thus about one-fifth that of the body, but in *C. strumosum* it is less than one-sixth, and in *C. semerme* it is more than one-quarter. The form of the organ in *C. australe* is rather slender, as in *C. strumosum*. There are 18 longitudinal rows of hooks, 13 to 14 in each row, a total of about 240. In *C. strumosum* there are also 18 rows, but each has 10 to 12 hooks; in *C. semerme* there are 22 to 24 rows each with 12 to 13 hooks. The hooks in *C. australe* are differentiated, the first four in each row being rather long, narrow, and pointed, the free portion measuring about 0.04 mm. in each case, while the basal part which lies in the proboscis is about 0.03 mm. in the first hook, increasing in succeeding hooks to become as long as the free portion in the fourth. From the fifth to tenth, the projecting portion is larger and more powerful, and the base as long as, or slightly longer than, the free part, but there is little, if any, increase in the length of the free portion (0.042 mm.; base 0.045 mm.). The eleventh, twelfth and thirteenth hooks (and fourteenth, if present) in each row are small and diminish slightly in length (0.025-0.023 mm.) and possess little or no basal portion. The arrangement of the hooks and their relative sizes are more like those of *C. strumosum* than those of *C. semerme*.

The proboscis sheath is double-walled, long and narrow (1.1 mm. by 0.25 mm.). The ganglion is in the vicinity of its mid-length. The lemnisci are thin, narrow structures each about half the length and breadth of the rostellar sheath. The delicate net-like lacunar system in the skin is typical of members of the genus.

The testes, each 0.04 mm. in diameter, are arranged one just a little more anteriorly than the other in that part of the body which contains the disc. The three pairs of narrow cement glands have an arrangement and form very like that in *Corynosoma semerme*. The lower end of the combined cement gland of each side is considerably swollen to form a fusiform structure. The ejaculatory duct opens into a short pointed penis projecting into an extensive bursa with folded walls when introverted. There is a large muscular sac ("markbeutel"). The male system closely resembles that of *C. semerme* as described by Lühe (1911) and Bieler (1914).

In the female, the uterus is long, narrow, and thick-walled, terminating in a short muscular folded vagina which appears to be made up of three short sections. The female aperture is terminal. In some specimens a "copulation cap" of cement was present resembling that figured by Van Cleave for *C. constrictum*. Eggs from the body cavity measure 0.075 to 0.085 mm. by 0.023 to 0.029 mm., with a short broad polar process at each end of the middle shell like that figured by Lühe and by Meyer.

In addition to *C. semerme* and *C. strumosum*, the following species have been described from seals: *C. hamanni* Linst. (*C. antarcticum* Rennie, *C. siphon* Raill. and Henry), and *C. bullosum* Linst. from the Antarctic and Subantarctic; *C. reductum* Linst., a rather large immature form from the Arctic; and

C. ambispinigerum Harada from a Japanese *Phoca* sp. An account of the last-named is not available for comparison.

Corynosoma sp. is the only species of the genus recorded from Australian waters, having been reported by Johnston and Deland (1929) from a dolphin, *Delphinus delphis*, in St. Vincent's Gulf. Lühe (1911) mentioned having met with *C. semerme* in an immature condition once in *Otaria jubata* and once in *Spheniscus demersus*. The former is one of the South American seals and the latter is the South African penguin. *C. strumosum* is known from northern European seals and cormorants; Ball (1930) identified it from the Californian harbour seal (*Phoca richardii*), and Meyer (1932) stated that it occurred in *Phalacrocorax capensis* in former German South-west Africa.
